

Number

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SOLID WASTE MANAGEMENT
Koror State, Republic of Palau

Manual for Composting

WRITTEN BY

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Table of Contents

	Page
1. What is Composting?	1
2. Methods of Composting	2
3. Steps to Start Composting	2
4. Overview of the Program	5
5. Responsibilities of Concerned Parties	6
6. Laws and Regulations of the Program	7
7. Staff Arrangement and Responsibilities	7
8. Outline (Design) of the Facility	8
9. Operation Schedule	8
10. Flow of the Operation	9
11. Facility and Equipment's (Capital Cost)	10
12. Reporting	12
13. Training	12
14. Promotion of the Compost	13
15. Finance	13
16. Challenges Experienced	14

1. What is Composting?

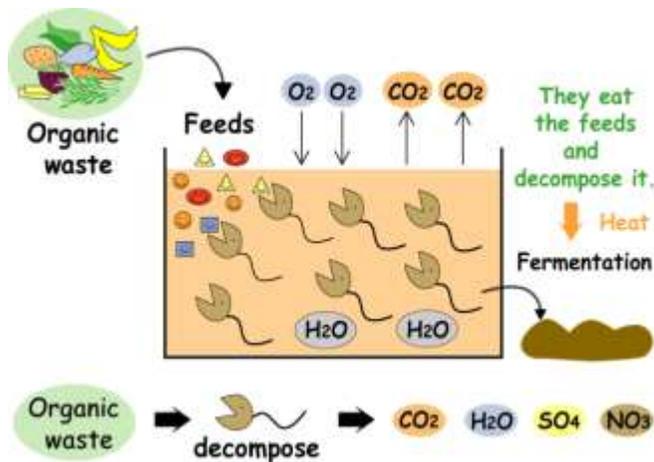
Composting is a specialized recycling activity in which organic wastes are biologically decomposed under controlled conditions to convert them into a product that can be applied to the land beneficially and without adverse environmental impact.

The process of composting under controlled conditions destroy pathogens, weed seeds, insect eggs, and other unwanted organisms. The final product from the composting process can be used to lighten heavy soil, improve texture of soil, and increase water retention capacity. This product can also be used as cover soil for landfills.

Composting is a natural process that has been used since the early 1900's by farmers to improve soil conditions for crop cultivation.



The following shows the decomposition process



The decomposition process is dependent on three major elements in order to activate. These elements are 1) Complex molecules which in basic terms can be defined as organic matters, 2) Microorganisms and 3) Oxygen. This process is basically the breaking down of organic matters into the smallest parts possible. This breaking down is the task of the microorganisms which live, breed and feed within and around the organic matters. Both the Organic matters and Microorganisms will eventually become the final compost material. Oxygen is essential as the microorganisms need air to survive and reproduce to speed up the processing.

Basic organic materials that can be used as feed for composting are grass trimmings, tree leaves, and non-odorous leftover foods like egg shells and vegetable parts. It is possible to compost all organic materials however; large and/or odorous materials require technological processing which can be costly to acquire and operate.

Tip: In order to produce good quality compost, the feeds to be used should be materials which contain good nutrients like protein, fiber and carbohydrates.

2. Methods of Composting

Here are some popular methods of composting.

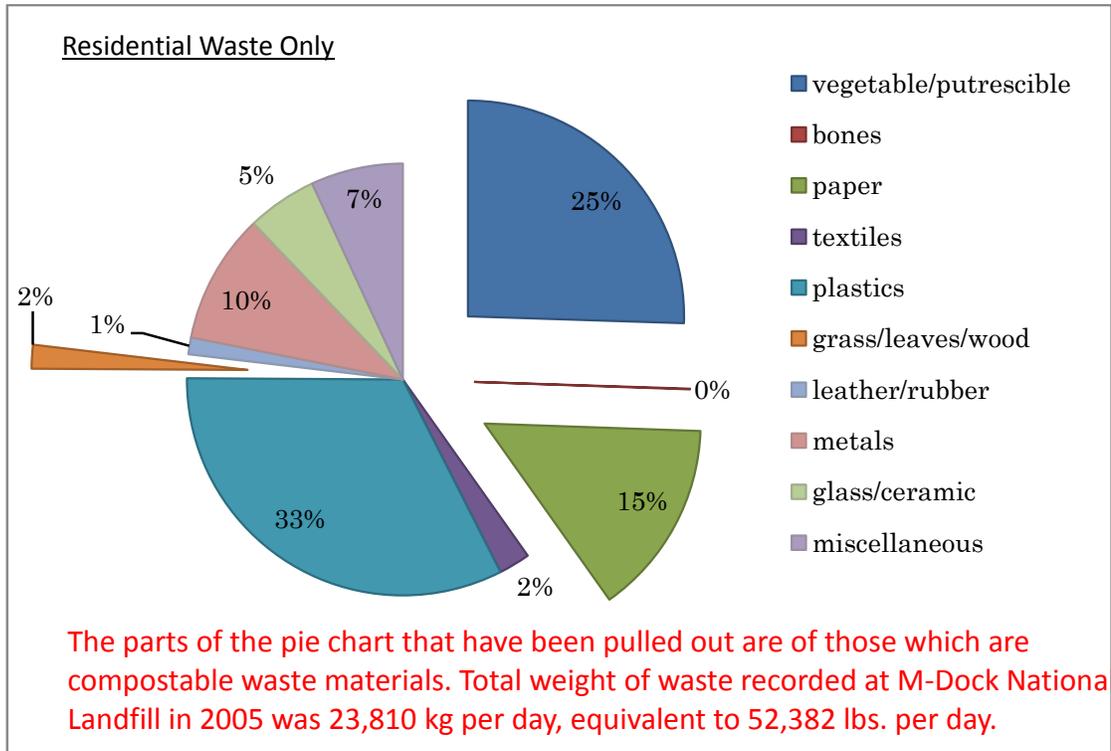
Composting Method	Feed Material	Idea of the Method	Advantages	Disadvantages	Running Cost (\$)
Home Composting	-Yard Waste -Kitchen Waste	Train householders to be able to conduct their own composting activities at home	Cost effective, Awareness raising, simple technology	Not all organic waste materials can be used with this method, low participation, Potential problems with flies, vermin and odor	unknown
Open Windrow Composting	-Yard Waste -Paper, Cardboard -Sewage Sludge	More of a commercial method to mass produce compost materials using heavy equipment's	Simple technology, Low capitol cost, technical skills not necessary	Potential problems with flies, vermin and odor, must consider water treatment plant for leachate, high running cost	\$39/ton
In-Vessel Composting	-Yard Waste -Paper, Cardboard -Sewage Sludge -Kitchen Waste -All organic materials	High technology method in which the composting process is conducted within a fully enclosed system	Produce high quality compost, can treat a wide range of organic materials, can control flies and odor	Necessary technical skills required for operation and maintenance, High capital cost, waste segregation necessary	\$14/ton

**Data Source – Integrated Solid Waste Management Plan (ISWMP) 1999 by Golder Associates.*

3. Steps to Start Composting

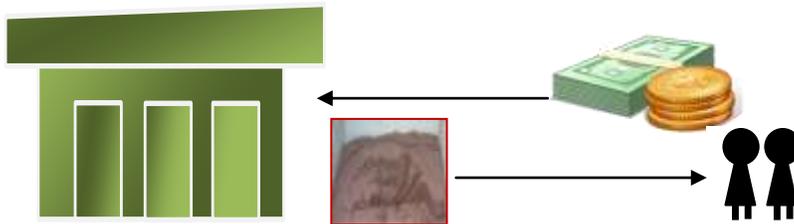
3.1 Feasibility Study

Composting was the number one option as the initial recycling activity to be experimented and conducted in Koror State for the fact that the feed materials needed for this activity were mostly produced on the island and are plentiful. A waste generation rate survey was first conducted to confirm this notion. The following data's will reveal the composition of waste and the percentage by each category. **Records from the year 2004*



As evidenced by the chart above, all combined compostable waste materials contribute about 42% to the total waste stream. This means that a total of approximately 10,000 kg of compostable materials are available to convert to compost or fertilizer every day. This can yield an estimated 5 Tons of compost per day.

Another important aspect of the feasibility study is market research. (*The details of this research are explained in subsection 3.2*). The research reveals the compost market to be over \$100,000.00 annually in the year 2005. It also shows that all of these compost and fertilizer products were being shipped in from foreign countries. This meant that producing compost locally and selling at a lower price could reduce the dependency on foreign compost products, also promote the use of locally made products, and more importantly establish a sustainable recycling program which has the capability to recover its own operation, maintenance and capital cost.



3.2 Market Research

The first order of business in market research is to investigate “supply and demand”. The easiest way to do this is to begin the investigation with the Customs or Tax office to try and determine the amount of foreign compost or fertilizer imported in a given year (preferably the recent past year). The next step is to interview business establishments such as hotels, landscaping companies, and even local farmers to get an idea of the amount of compost or fertilizers their businesses consume annually along with the costs if possible.

It is also possible that local hardware stores import compost and fertilizers for resale to homeowners and small scale farmers or gardeners. If this is the case, it is necessary to interview the owners or managers of hardware stores to determine the amount of fertilizers being sold through local stores.

Following are the actual results of the initial investigation into the Compost Market of Palau.

Palau’s Compost Market in the year 2005

Year 2005			
Total imported foreign fertilizer: 16,500 ft³(Cubic Feet) or 168 tons (Customs clearance records)			
User or Vendor	Consumption (ft ³)	Consumption (t)	Cost (\$)
Hotels	3,300	34	\$32,644.00
Hardware Stores	9,500	96	\$61,625.00
Local Farms	*3,700	*38	*\$24,650.00
Total	16,500	168	\$118,919.00

3.3 Method Selection

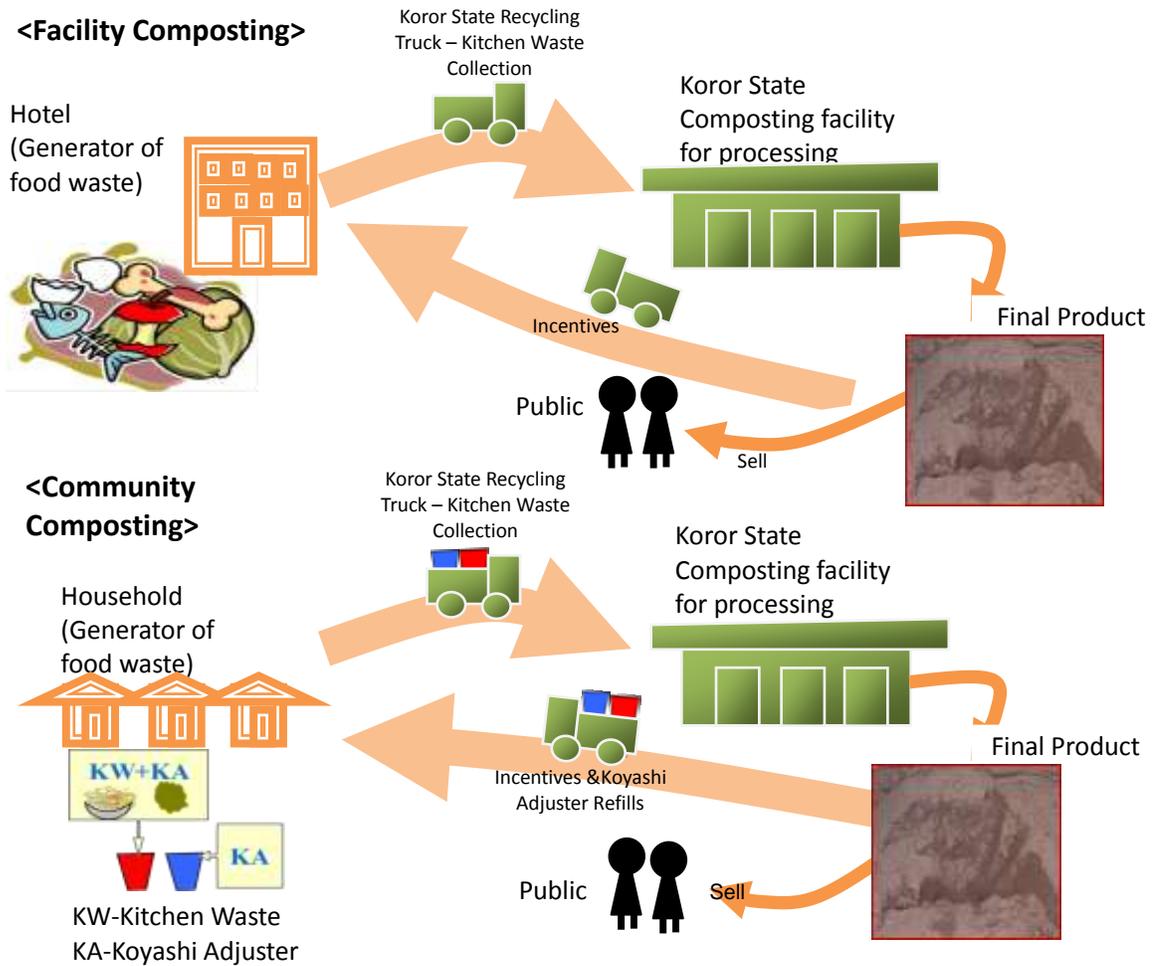
Selecting a method for composting depends on the goals and objectives in which an organization or individual is trying to achieve. Based on the goals and objectives of the KSG - Solid Waste Management Office which ultimately aims at waste reduction with emphasis on a sustainable waste management system, the In-Vessel Composting system is ideal for the fact that it is able to treat a wide range of bio-degradable waste materials. Also compared to the Open Windrow Composting system, the In-Vessel requires fewer personnel and equipment’s and a smaller land area for its facility. Another major deciding factor is the running cost of the composting systems indicated in section 2 of this manual.



It is also necessary to conduct experiments like COD tests, material combinations, temperature and comparisons and record data’s from these composting experiments. It is important to try different approaches to how you conduct the activity in order to find the most effective procedures. The records of this experiments will be the essential factors in the selection of the composting method to be utilized. It is also recommended that a waste generation rate survey be conducted to identify the availability of the different types of feed materials which can be used for composting. This will not only help in the planning for an adequate composting method but will also help in the planning for the scale of the facility and operation.



4. Overview of the Program



Community Composting Collection
Inset: Blue Bucket-KA
Orange Bucket-Sandwiching KA & KW



Final Compost Product to be sold to public and/or donated to contributors as incentives.

6. Laws and Regulations of the Program

There are no current laws or regulations pertaining to the composting program or the recycling of bio-degradable waste materials. Currently, the (NSWMP) National Solid Waste Management Plan entails all implementing organizations to pursue composting activity as an approach to reducing bio-degradable waste materials from the total waste stream.

This program is promoted only by encouragement through incentives as well as environmental education and awareness programs.



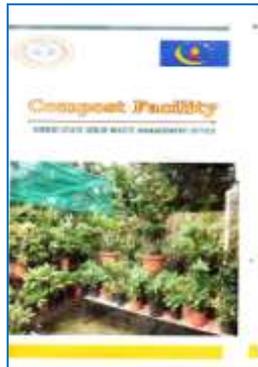
Hosting Facility Tours for Students



Awareness Campaigns



Program Introduction to Hotel Operators

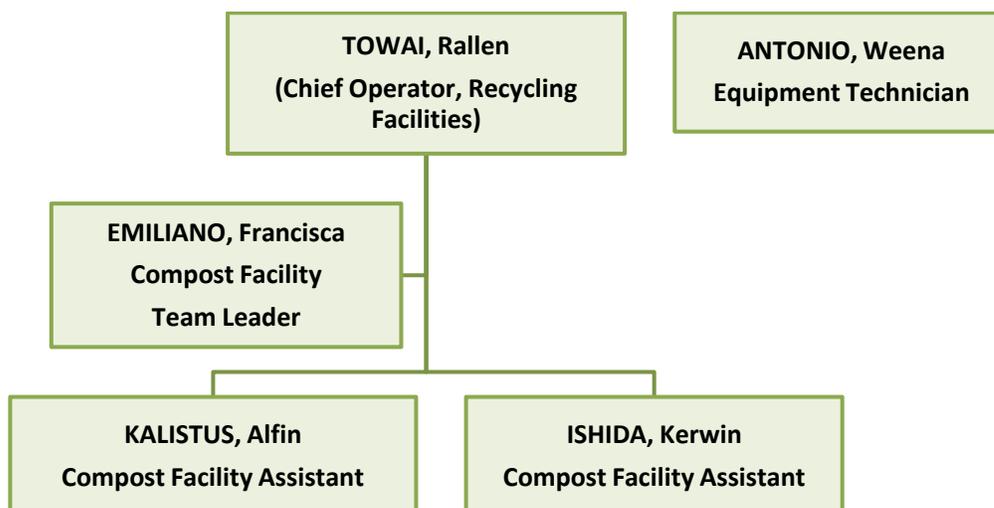


Brochures



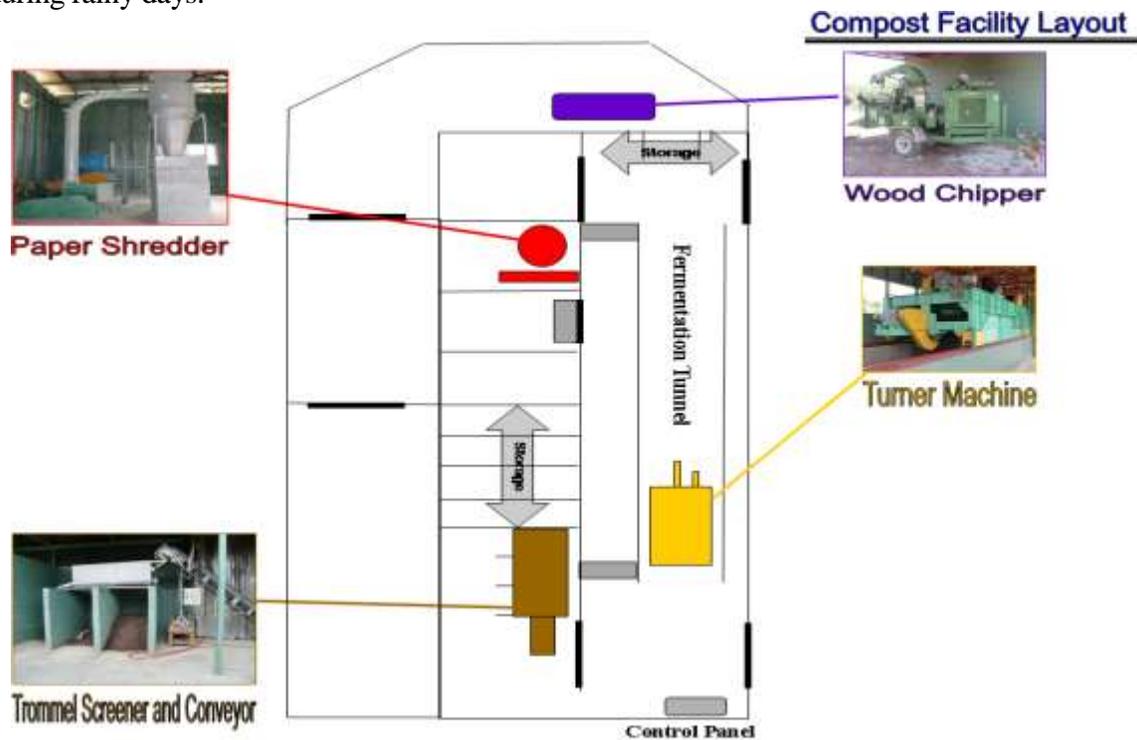
Quarterly Newsletters

7. Staff Arrangement and Responsibilities



8. Outline (Design) of the Facility

The Koror State Compost Facility was constructed in 2008 and began its operations in early 2009. Since then it has been through 3 phases of building extensions to make room for additional storage spaces, a machine room for paper shredding and extension of roofing for a more effective working environment during rainy days.

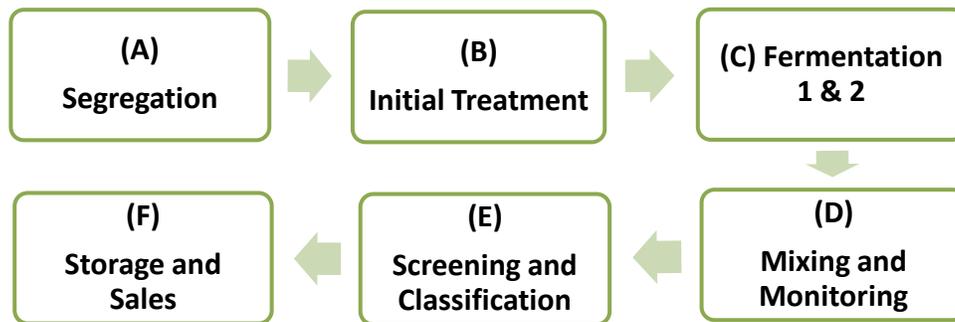


9. Operation Schedule

Daily Operation Routine

Time	Activity	Who
7:30	Preparation of equipment's and personnel for Operations	All staff
8:00	Collection of Kitchen Waste from Hotel, preparation of pre-treated yard waste for covering kitchen waste, operation of Wood Chipper depending on availability of yard waste	All staff
9:30	Segregation of collected waste, stocking of recyclable materials, covering of kitchen waste and recording of data's	All staff
10:00 – 11:30	Continue pre-treatment of yard waste and preparation of paper materials for shredding	All staff
13:00	Continue pre-treatment of yard waste, operation of paper shredder, loading of materials into fermentation tunnel, and data recording	All staff
16:00	Clean up, secure equipment's and facility	All staff
16:30	End of the working day	

10. Flow of the Operation



A. SEGREGATION

- Manual separation of different categories of waste
- Data Collection – measurement of kitchen waste to be processed
-

B. INITIAL TREATMENT

- Wood chipping
- Paper shredding
- Covering of kitchen waste with chipped yard waste

C. FERMENTATION PHASES 1 & 2

- (Phase 1) Stockpiling of chipped yard waste for at least a month to allow for decomposition process to activate
- (Phase 2) Mixing of decomposing yard waste with kitchen waste
- (Phase 2) Loading of stockpiled materials into fermentation tunnel

D. MIXING AND MONITORING

- (Turner Machine) Mixing and turning of fermenting materials to allow for full aeration. *This activity is conducted twice a week normally but at times it is conducted more often depending on the demand for the product.*
- Monitoring through collection of data (temperature), visual and odor checks. *This activity is conducted daily.*

E. SCREENING AND CLASSIFICATION

- (Trommel Screener and Conveyor) Screening and classification of materials into three different products
- Product 1: Grade A compost. Fine material.
Product 2: Grade B compost. Coarse material.
Product 3: Grade C. Used as backfill for access road maintenance.

F. STORAGE AND SALES

- Final compost products are stored and sold to walk in customers
- Donated as incentives to major contributors and SWM Program participants such as community composting participants.

Challenges Faced

*Initiation Phase:

The method used for mixing kitchen waste with yard waste. Initial method was mixing fresh kitchen waste with freshly chipped yard waste. This didn't help in odor and vermin control. After a few experiments it was figured that covering kitchen waste with already decomposing yard waste would control vermin and odor. *Decomposing yard waste can produce intense heat which will repel vermin as well as continuously cook the kitchen waste to reduce odor.*



11. Facility and Equipment's (Capital Cost)

Facility	Description	Cost (US\$)	Funding
Initial Phase	Construction of main compost facility with fermentation tunnel and electrical works	\$105,000.00	\$100,000.00 (KSG) \$5,000.00 (Japan Government Grant) for electrical parts
2 nd Phase	Concrete flooring of Wood Chipper area, Construction of Final Compost Product Storages and Trommel Screener and Conveyor area	\$20,000.00	KSG
3 rd Phase	Construction of machine room to house Paper Shredder and concrete flooring of the front area	\$40,000.00	KSG
4 th Phase	Roofing of the Wood Chipper area and the front area, construction of equipment and supply storage room, and fabrication & installation of storage gates	\$20,000.00	KSG
TOTAL COST FOR FACILITY		\$185,000.00	

MachineName	Purpose of the Machine	Description	Cost (US\$)	Funding
Wood Chipper	Used for chipping yard waste such as tree branches and leaves	Brush Bandit Chipper Model No: 200+	\$40,000.00	Donated by SPREP
Paper Shredder	Used for shredding paper products and cardboard boxes.	Morimoto Corp. DA-820A SB-250L	\$36,000.00	KSG
Turner Machine	Used to turn fermenting compostable materials for the purpose of aerating to speed up fermentation process and eliminate the generation of hazardous gases.	Ryoko Industries Co – Ltd. RTK-20-15-1	\$40,000.00	KSG
Trommel Screener and Conveyor	Used to screen final compost material to classify and remove unwanted materials from the final product.	AEM ATR/50200	\$25,000.00	KSG
Skid Steer Loader #703	Used to transport ready materials for screening and storing	TCM SSL 703	\$10,000.00	KSG
Skid Steer Loader #706	Used to move and stockpile yard waste, cover kitchen waste and load materials into fermentation tunnel	TCM SSL 706	\$15,000.00	KSG
Bulldozer	Used to move large piles of chipped yard waste to the first phase fermentation area and maintain access road to delivery area (Wood Chipper area)	Komatsu D21A	\$35,000.00	KSG
Blowers (3 ea.)	Used to provide constant air supply to the fermentation tunnel for aeration of in-treatment materials to allow for rapid processing	GAST Regenair Blowers R4 Series R4310A-2	\$3,500.00	KSG
TOTAL COST OF EQUIPMENTS			\$214,000.00	

***Total Investment into Compost Program:
\$399,500.00 including Donations***

12. Reporting

Data's are recorded daily during operation of all machinery and equipments.

-Types of reports:

- Raw data reports of materials before and after pre-treatment.
- Daily Temperature Reading and Recording of Tunnel material to determine the stages of decomposition.
- Daily operation and maintenance checks of equipments.
- Final Compost Material Production Report
- Monthly Sales Report prepared by Financial Officer

All reports are submitted to the SWM Manager and Consultant for compilation. The finalized reports are analyzed and used to improve the program in terms of additional human resource, equipment's, facility expansion and technical planning and training. Incoming compostable material and sales reports are to be assessed to determine as well as project production rate, waste reduction rate and sales.

13. Training

Newly hired employees who will be assigned to the Compost Facility are required to go through what is called "fundamental or basic training". This training is usually conducted by the Recycling Center Chief Operator and the Consultant. It is basically an orientation in which the trainees are briefed on the basic information's on the fermentation and decomposition process of organic materials as well as the composting method and its features, work procedures, and equipment operation and maintenance. Newly hired personnel are to be in training for the full extent of their 3 months probationary period.

Other trainings:

1. General training on Safe Operation and Maintenance of Equipments

- By request from KSG-SWMO.
- Conducted by Mr. Eugene Uehara, certified by U.S Department of Interior (DOI)
**Employees whose job duties require them to operate forklifts, loaders and trucks must attend this training.*

2. Work Zone and Personal Safety Training

- Conducted through Palau Community College
- By U.S Federal Program (MAP) Maintenance Assistance Program. (Mr. Don Hanser, Coordinator and Mr. Johnny Kintaro, Instructor).

14. Promotion of the Compost

The compost products are promoted through Media (Television, Radio, Newspapers), Community Workshops, and even brochures and handouts. It is also promoted through donations, where the compost products are donated to certain organizations and individuals, who we then use their successful experiences with the compost for further promotion through word of mouth.

Even though the compost is promoted for public sales, it is viewed as a more important tool to utilize as incentive in the promotion of other solid waste management activities and programs. For example, it has been used to promote and strengthen the community composting program and it also has been used to promote segregation through rewarding communities who properly segregate waste in the Waste Segregation Stations.

15. Finance

There are three different grades of the final compost product after screening as mentioned previously.

- Grade A compost is sold for a price of \$5.00 per ft³ (Cubic Feet).
- Grade B compost is sold for a price of \$2.50 per ft³ (Cubic Feet).

**A cubic foot is comparable to (1) twenty pound sack of rice.*

- Grade C will be used as backfill material for road maintenance and can also be used for cover soil in the landfill. This grade is not for sale.

The prices above were decided upon based on annual operation expenses of the composting program and projections on the potential volume of compost to be sold per year.

Currently, the compost program realizes an average of \$5,000.00 annual revenue. This income is enough to cover utilities such as water and electricity and some other minor expenses or an estimated 13% of the total annual operating cost of the Compost Program. With the Beverage Container Deposit Fee Program and its financial mechanism, Koror State Solid Waste Management Office realizes an average annual income of \$500,000.00. This makes it unnecessary to further market the compost products, thus far allowing the opportunity to utilize this product as an educational and awareness raising tool.

It should be noted that the primary goal for this program is to reduce waste. Making sales is secondary.

16. Challenges Experienced

Throughout the employment of the composting program, many challenges were faced. Such challenges include but are not limited to operational procedures, equipment's, human resource, facility and financing.

The challenges mentioned above are all connected in a way. Operational procedures really depend on experimenting and finding the most effective ways to conduct the activity. This might take a few experiments or a very long time depending on the resources you have in place. As the staffs continue to build knowledge and skills, the project starts expanding and the need for additional equipment's and a bigger facility becomes a demand that must not be ignored. All in all, the most important thing is to have the right people in place, from top to bottom. It is imperative to have leaders (law and policymakers, executives) who are aware of the impacts of solid waste and are committed to supporting waste management activities through creation of laws, regulations, and the provision of funds. The implementing body must employ individuals who are highly motivated and committed to preserving and protecting the environment. And last but not least, it is very critical to employ the knowledge and skills of an expert(s) to guide us along the way.



The Compost Team a.k.a SPECIAL FORCE



Thank you very much for taking the time to read this manual.
Please contact the Koror State Solid Waste Management Office for any queries regarding the information's presented in this educational manual.

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This is an educational manual created with the experiences of the Koror State Solid Waste Management Office to educate and help those who wish to pursue composting as a form of solid waste management activity or recreational activity. We sincerely hope it will benefit you.